The Future of Health Care for an Aging United States

Report of the
Workshops on
The Future of Health Care for
Our Aging Population

Sponsored by
Sandia National Laboratories
Advanced Concepts Group

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Executive Summary

The population of the United States (and of the other developed nations of the world) is rapidly aging. The population 65 and older is approximately 33 million in the U.S.; it is projected to be 53 million by 2020 and 77 million by 2040. This aging population will place a growing financial burden on the national economy and present a potential danger to national security and well being.

In August 2000, the Sandia National Laboratories Advanced Concepts Group held two workshops, of one and a half days' duration each, to bring together health care leaders to discuss the needs of a future health care system that could meet the challenges posed by a rapidly increasing older population.

Participants in both workshops represented different parts of the current health care system. The first workshop developed a vision of the health care system of the future. The second workshop identified the changes that needed to make the vision possible, related barriers to attaining the vision, and solutions to address those barriers.

The envisioned health care system of the future would be designed to prolong each person's healthy life and reduce the period of decline and debilitation. The vision derives from a systems approach to health care based on six elements:

- Changing the expectations of what it means to be "elderly";
- Adopting a "Life-Long Contribution" rather than a "Work in Order to Retire" paradigm;
- Delivering health care to the individual rather than delivering the individual to health care;
- Shrinking institutional care;
- Replacing general hospitals with specialized facilities; and
- Shifting the locus of medical decision-making back to the individual.

This vision might be enabled by:

- Technology that collects and meaningfully analyzes more accurate, more sensitive, and more specific information that will allow for
  - better maintenance of personal well-being;
  - more effective and earlier medical interventions against diseases;
- Technology that empowers more people with less medical training to determine or provide reassurance about the state of their own or other's health;
- Medical science the permits individualized medications, therapies or treatments,
- Communications technologies that enhance social and family interactions, even among individuals in physically separate locations; and
- Robotic devices, perhaps controlled or monitored by humans physically located somewhere else, that assist disabled persons or their caregivers—Human Assisted Robots Assisting Humans (HARAHs).

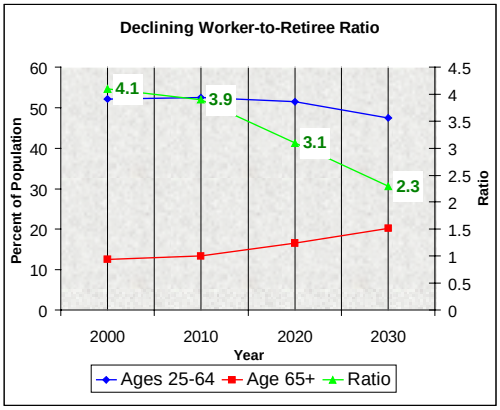
Participants in the second workshop emphasized the need to maintain both human interaction and respect for human diversity. Making the vision real will require a fundamental shift in the way that society views the elderly and their role in the community and this shift will have a significant education component. Other necessary changes include new ways to develop a sense of community between the aging and the rest of society, changes in the way we finance and provide health care, and changes in the health care technologies.

The second workshop also identified barriers to achieving the vision and solutions to those barriers. These barriers reflect the complexity of changing our current health care paradigm.

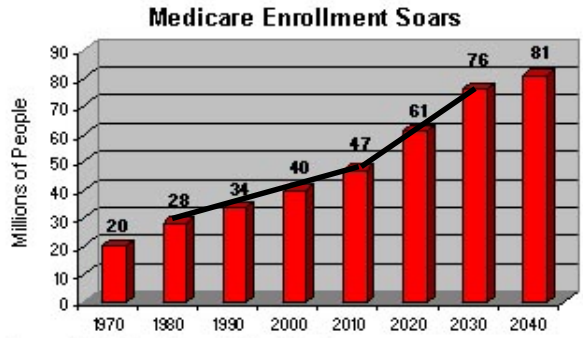
The existing system is sustained in part by strong attitudes and perceptions about what it is to be elderly and by established perspectives on how individuals and society should receive or provide health care. Barriers also include financial and regulatory systems that resist change. For example, Medicare does not pay for the electric wheelchairs that could play a significant role in increasing the independence of the disabled. Nor are the technologies that would enable the vision quite ready—either in direct applicability, in affordability, in flexibility, or in the degree to which it is user friendly. The range of proposed solutions to these barriers makes it clear that purposeful change will have be based on a systemic, multidisciplinary approach. Crosscutting themes running through the workshops included the complexity of the health care system and of changing it, the need for education at all levels, and the need to enhance the role of non-doctor caregivers in the system.

Introduction

In the coming decades, graying populations will impose enormous economic burdens on the U.S. and its major allies, with huge impact on their defenses. In the U.S. alone, by 2030 there will be only 2 Americans aged 15 to 64 for every one 65 and over, compared with today's 4 to 1 ratio. The situation will be even worse for the other industrialized states. As a result:



- We and are allies won't be able to pay for pension and health care commitments, let alone find the resources keep up our military establishments;
- Our military will have to compete for people in economies already suffering labor shortages;
- We won't be able to increase our military budgets to meet any new national security threats;
- We won't be able to borrow from each other to finance our deficits;
- Discord between young and old will prevent consensus on outward-looking global security policies;
- Weakened military potential could mean a less stable world, further slowing economic growth and so making a vicious circle of declining prosperity and home and more conflict abroad.



Source: Health Care Financing Administration

The only way to sustain our national economies and defense capabilities will be to reduce pension and health care costs by making it possible for older people to stay productive and healthy longer.

In August 2000, the Sandia National Laboratories Advanced Concepts Group held two workshops, of one and a half days' duration each, during to bring together health care leaders to envision a health care system for the future.

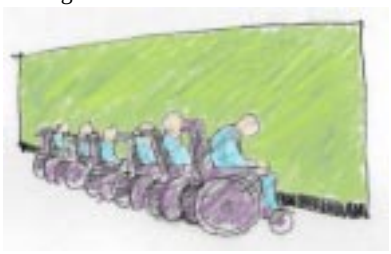
Workshops participants challenged each other through an iterative process of discussion and revision. The first workshop developed a vision of the health care system in 20 years. The second workshop then identified barriers to achieving that vision and preliminary solutions to the barriers. An important reason for holding two separate workshops was to allow the first workshop participants to develop a vision statement unconstrained by any concern about barriers.

The workshops were small enough to allow free discussion, but large enough to allow representation from a cross section of the current health care system. Participants included geriatric physicians, medical researchers, state agencies on aging, clinical nurses and healthcare administrators. Appendix B lists the participants.

Workshop I: A Vision of the Future of Health Care for Our Aging Population

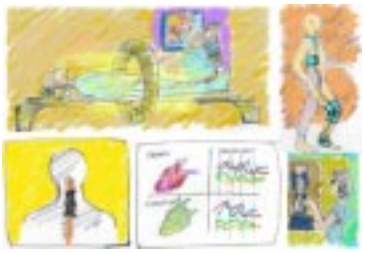
Maintain Independence and Mental Well Being

Aid the Caregiver



Improve Institutional Care

Educate the Workforce of the Future



Advance the State of the Art in Medicine

The objective of the first workshop was to develop a vision of the future of the health care system for the elderly and of the role of technology within that vision. ACG staff suggested to participants that the vision should be based upon maintaining the dignity and self-worth of the individual, therefore include attention to:

- maintaining the independence, productivity and well-being of the elderly population;
- providing support (skills, physical, mental, psychological, etc.) for the caregiver;
- improving institutional care;
- educating health care workers (and caregivers); and
- advancing the state-of-the-art in medicine.

In addition, such a vision would probably include changes in the day-to-day lives of the elderly in areas such as:

- increased social interactions;
- increased or augmented mobility and/or physical ability; and
- increased mental acuity (which may affect well being and the healing process).

To keep the participants in touch with the human element of the problem, the ACG opened the workshop with brief video clips from interviews with several elderly people and their caregivers. These interviews included:

- an elderly widow who had recently had a knee replacement, but had family support since she lives with her son;
- an elderly woman who is dealing with major lifestyle changes in response to her husband's recently discovered serious health problem;
- a middle aged woman dealing with functional ability losses associated with multiple sclerosis; and
- the caregiver for an elderly woman with serious health problems.

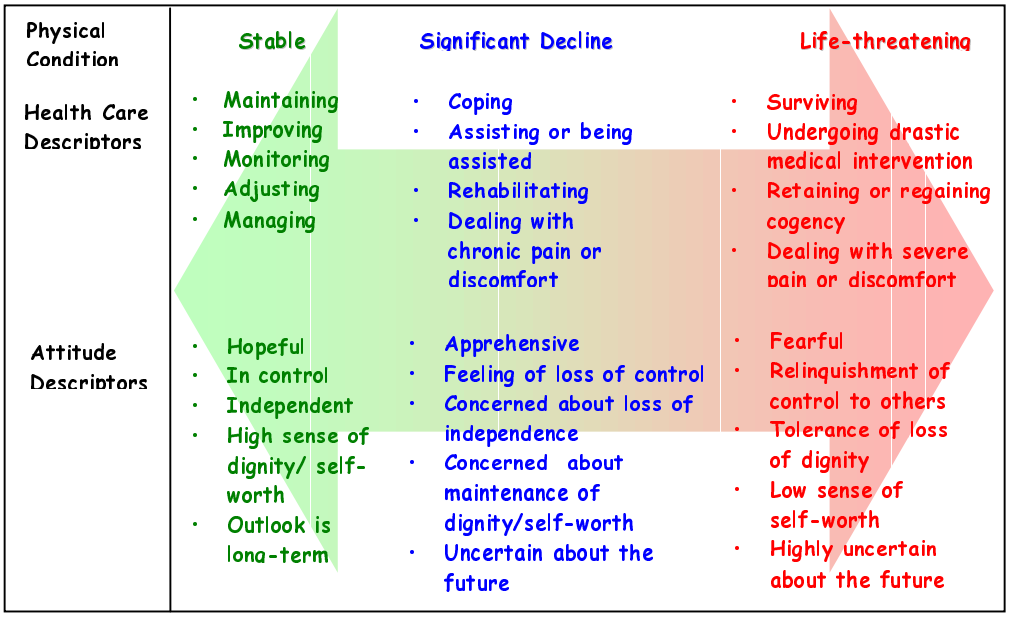
Who are the "elderly"?

Workshop participants first discussed what is meant by the term "elderly." Society's understanding of what it is to be elderly is changing. When the Social Security Program was instituted in 1935 the average male life expectancy was 62 and the expected age of retirement from work was 65. Therefore, statistically, it was more likely than not that any given individual would work until he died and would not collect social security benefits. Today, the assumed retirement age is still 65, but the average life expectancy for males has risen to 73.6 years, and for females to 79.4 years.[1] Furthermore, people are not just living longer; they are living healthier—able to live productive lives after 65.

[1] *National Vital Statistics Report*, Vol. 47, No. 28, December 13, 1999.

Participants concluded that being "elderly" has as much to do with health or disability as it does with age. A fully functional 70 year-old, for example, is less the focus of what it is to be elderly than a partially disabled 60 year-old. The discussion of how we understand what it is to be elderly started with the suggestion that there are three major health related phases into which the aging population would fall—stable, significant decline, and life threatening.

In the *stable phase*, the health care status of an individual is not rapidly changing. Care is focused on maintaining, managing, or monitoring of various health-related characteristics. In general, these individuals are independent of caregivers and in control of their daily activities.



The *significant decline phase* brings significantly declining physical or mental functionality. A person in this phase may have recently acquired a life-style altering disease or disability, or be dealing with a chronic problem in which decline is becoming evident. Care consists of such activities as help in coping with the event or disease, assistance in the activities of daily living (ADL), rehabilitation, or support in dealing with chronic pain or discomfort. People in this phase may suffer decreased independence, mental struggle over loss of control, perceptions of declining self-worth, loss of a sense of dignity, or by uncertainty about their health futures.

The *life-threatening phase* sees diseases potentially leading to death. Care consists of severe medical interventions, aid in retaining or regaining cogency, coping with severe pain and discomfort, and frequent assistance in performing ADLs. These patients may suffer severe loss of independence, perception of low self-worth, loss of sense of dignity, loss of control of daily function, or high uncertainty about the future.

After extensive discussion, participants agreed to focus on the two phases, stable or life threatening. The group concurred that, in the ideal health care delivery system of the future, 20 to 25 years out, the significant decline stage would be relatively short.

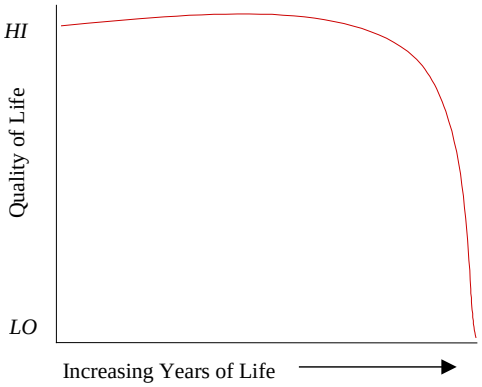
The Health Care System of the Future

The goal motivating the vision developed here of a future health care system is to make it increasingly the case that aging not be associated with disability or nonproductivity, but instead with continued importance to the community. Achieving that goal would require a fundamental paradigm shift in how society views what it means to be elderly. It will mean that, as we grow older, we think not so much in terms of working until we retire but of lifelong involvement in and contribution to the community. It will mean finding fulfilling and meaningful ways for the elderly to be mentally and physically active within the community.

In parallel with the need to shift how the elderly are viewed as part of society, there will need to be a shift in how health care is delivered to them. As suggested earlier, the health care delivery system would focus on two phases, stable and life threatening. The goals of such a system would be to:

- extend the productivity stage of the elderly by flattening out the "stable phase" and reducing the “declining” stage, leading up to the point where "life threatening” phase is very short;
- decrease the cost of care during the stable phase while minimizing the cost of care during the "life threatening" phase; and to
- maintain the sense of dignity and self-worth of the elderly throughout, especially during the "life threatening" stage.

This vision can be graphically expressed as follows:



For economic and social reasons, society would shift away from providing care through medical institutions and toward home health care. This “de-medicalizing” of society would continue, with help from technology, a trend present in today’s medical environment. Related to de-medicalizing society were observations that in the future medical environment there will be fewer "general hospitals" and more "specialty hospitals” and that there will be a trend towards in-home, rather than nursing home, rehabilitation possibly via "tele-rehabilitation.” Workshop participants estimated that as much as 80% of primary care visits have nothing to do with treatable conditions, but are part of a search for reassurance. Increasingly screening, diagnostic, and information tools in the home could serve as decision filters, advising when professional medical care is warranted, thus reducing the burden on the health care delivery system and allowing other mechanisms to serve as reassurance vehicles.

The ultimate result of these changes would be to shift more decision-making authority and responsibility about health care to the individual. Out of the discussion emerged a sense of how the technology of the future will enable the vision and preliminary scenarios of how it would play out.

The Technology of the Future

The technology that could help meet future health care needs (including reassurance) would increasingly involve “tele” delivery and require universal access (connectivity) to a wideband communication system. Collective caregiving and communities of care would be combined with a re-emergence of the family unit as part of the community. One scenario envisages an elderly person or persons attending a "virtual dinner" with family present either in 2-D audio/video and/or 3-D holographic presentation. Another scenario proposed a tele-surveillance capability where an elderly person could allow family members to virtually monitor his activity. For example, a sensor could be used to indicate when the refrigerator door is opened, indicating that that relative might have eaten. Alternatively, the elderly relative could provide "virtual baby sitting” from a distance, thus continuing to contribute to the well being of the family.

Participants agreed as a group that technology could play an important role in improving the health and quality of life of the elderly. However, technology alone is insufficient for providing future health care and it is critical to retain the "human touch.” A physician among the group put it best, saying, "an elderly individual who is dying does not want to speak to a robot, an engineer, or a technologist, but rather a well-trained, compassionate physical or medical professional."

Nevertheless, technology developments that could contribute toward prolonging the “stable phase” would incorporate at least the following elements, and probably others as well:

- interactive "smart" or “aware house” technology (unobtrusive or wearable monitoring devices);
- in-home screening of medical status via low-cost peripherals;
- low maintenance medical devices for screening and diagnostics with the “intelligence” located locally, not remotely;
- an in-home robotic caregiver or provider, perhaps controlled by a human from a remote location via telecommunication technology, (Human-Assisted-Robot-Assisting-Humans--HARAH);
- a stable repository for personal health information (i.e. medical records) managed by the individual or her agents; and
- advanced prognostic tools that enable that better informed personal and medical decisions toward the end of life.

Descriptions of a phased model of a health care delivery system

The workshop participants developed the following descriptions of three phases in the health care delivery system of the future: stable, stable at a later stage, and end-of-life stage.

Stable Phase

Judy is a 72 year-old who has successfully transitioned from working full-time as a researcher at Sandia National Laboratories to a second career as a part-time educator: she teaches mathematics, both to an audience on a Navajo Indian reservation and to a group of students in Harlem, NY, via distance learning. She has developed limited mobility, coronary artery disease, and diabetes.

Technology advancements have increased Judy's ability to remain a contributing member of society. Some advancements include:

- continuous in-home medical surveillance, for example
  - wireless, personal physiologic monitoring of blood glucose, ECG, temperature, blood pressure, oxygen saturation, EEG
  - wrist and foot sensors to monitor joint mobility, joint inflammation, blood flow to joint, and also gait characteristics;
- advanced diagnostics based on
  - virtual human models (digitized representations of individual human bodies and their functions)
  - more, and more complete data on the parameters the health of individuals;
- periodic home-based monitoring, screening, and diagnostics including
  - carotid artery ultrasound
  - cardiac treadmill tests;
- passive monitoring of activity via unobtrusive monitors in the home
  - motion, position, status sensors

  eating, diet, nutrition, consumption
- interactive, computer assisted home customized to personal thresholds, tolerances
  - food preparation
  - housekeeping
  - human assisted robots (HARAH)
  - user-specific programming, activity suggestions, advertising;
  - education;

- resurgence of family and community bases through tele-conferencing abilities
  - "virtual dinner"
  - "virtual family visits", "virtual baby-sitting"
  - distance and/or remote support groups; and
- improved transportation infrastructures for better mobility
  - short distances: mobility outside of home, around town
  - long distances
  - within home: patient initiated/robot assisted movement.

Stable at a later stage

Judy at 85 years old is in a critically ill state and has acquired dementia. She requires more assistance and has become progressively less productive than she was at 72 years old. Many of the same technologies that supported Judy during her "stable" phase still exist, but the additional acquired disability of dementia necessitates real-world assistance for performing daily tasks. The requisite of physical assistance may take the form of a real person caregiver assisting Judy, and/or human-assisted robots or HARAHs in which a human at-a-distance (perhaps younger "elderly") controls the robot to provide physical care.

The participants felt it important to note that the vision articulated does not adequately address the consequences of mental degeneration stemming from dementia, senility, and degenerative diseases such as Alzheimer's.

End-of-Life Phase

In the "end-of-life" stage, the same resources and technologies from the earlier phases are still available. For this population, three outcomes are likely:

- change in patient status from "end-of-life" returning to a "stable" stage where one is productive and contributing to society;
- patient health status is maintained, i.e. not improved dramatically nor declining rapidly;
- imminent death.

With this population, consideration must be given to coping with degradation in functionality and to supporting "dignity" in dying. Medical interventions require careful consideration of the benefit to the patient vs. the cost of the intervention. It was suggested that "quality-adjusted-life-year" (QALY) is a useful measure that normalizes the cost of a medical intervention per life year potentially gained. For example, does a patient with dementia or Alzheimer's disease need a hip replacement? What is the cost (both financial and personal) of the procedure relative to the return or benefit to the patient?

Given the high probability of death at this stage, participants discussed the potential value--for patients, family members, and friends--of diagnostic technology to predict "time-to-failure" (i.e. death). Better prognoses would allow those concerned to prepare physically, mentally, and psychologically for the inevitable. Decisions about medical interventions toward the end of life could be made on the basis of the chances for full recovery, partial

success, or even harm from the interventions performed. Regarding this potential technology and data acquisition, participants noted that cultural and religious issues are very important and could have a significant impact on decision-making surrounding death.

Summary of Vision from the first Workshop

The first workshop developed a vision for the health care system for the future that contained the following themes.

The goal is to maintain productivity and independence

To avert the impending crisis of pension and healthcare costs for a very large elderly population, we must figure out how to capitalize on the assets of this population and make them as healthy as possible - both mentally and physically.

The means of achieving this goal would include:

Changing the expectations of what it means to be "elderly"

Even if we are successful in providing better medical interventions and assistive approaches, we will still not be able to reap the benefits for society if we continue to think of an individual's age, rather than abilities, as a limiting factor in potential contributions to society.

Adopting a "Life Long Contribution" rather than a "Work in Order to Retire" paradigm

If we continue to extend healthy lifespans, we need to make a societal and cultural shift to take advantage of the assets of this older population. In so doing, we would serve the need of the individual to maintain a sense of dignity and self worth. Interestingly enough, this shift would also support the increasingly respected theory that mental health will be improved through enhanced mental activity.

Delivering health care to the individual rather than delivering the individual to health care

This approach should lead to cost savings. It also tends to level the playing field for people with decreasing functionality. Focusing care on the person instead of on the institutional needs of the medical providers would support the individual's need for dignity and control over one's own health. When technology enables this kind of health care, people are likely to demand it in increasing numbers.

Shrinking institutional care

The ability to deliver more services to the individual, in turn, will enable more people to live at home (or in a group home setting) longer. Thus institutional care will not be the preferred solution and the need will shrink.

Replacing general hospitals with specialized facilities

The need for general hospitals would decline as more general care is delivered to the home. People will be likely to go to specialized care centers for specific treatments. (However, care, in whatever setting, will still be delivered to the person in an integrated way, with her entire condition and circumstances fully taken into account).

Shifting the locus of medical decision-making back to the individual

The shift of decision making closer to the individual helps to address the need for dignity and self worth. In this paradigm, the medical provider becomes the patient's advisor and councilor to the patient and his family, rather than the omniscient dispenser of medical orders.

The goal will be enabled by:

Predictive Technology

In the health care system of the future, sensors and monitors for various indicators of human body functions should allow for more, more accurate, more sensitive, and more specific data to be gathered on an individual. Improved filtering and analysis techniques would then permit better and earlier interventions. As scientific understanding of the human body improves, so should the ability to predict the potential for successful interventions against disabling conditions and accurate prediction of end-of-life conditions.

Distributed Reassurance

Recent studies have indicated that many encounters with medical practitioners actually consist of "reassurance" visits. In the future, improved technologies should enable lesser-trained people to reliably dispense this dimension of health care—or enable the more highly trained practitioners to do so at a distance.

Designer Therapies

As our understanding of the individual genome increases, our ability to deliver highly individualized drug and other therapies will increase. This, along with individualized diagnostic technologies such as the virtual (digitized) human, holds the potential for treatments that are not just effective for the majority of people, but are effectively tailored to the specific individual. Early and more effective interventions should decrease the need for costlier, more severe treatment of advanced conditions.

Virtual Community

The mobility of our society disrupts the continuity of or social relations, with family frequently located over large geographic areas; broadband communications technologies may allow the enhancement of social interactions via the creation of virtual communities. Such interactions might include such things as a "Virtual Dinner Table," where family members can engage in dialogue, emulating having dinner together while geographically separated.

Human Assisted Robots Assisting Humans

Many tasks that are difficult for those with functional disabilities might be accomplished with the help of robotic devices employed by the disabled person or his caregivers. These robotic devices would not have to be completely autonomous. In fact, the best way to aid people with decreased physical function will probably be the one in which a human with specialized knowledge and judgment uses a robot to accomplish tasks that would be beyond the human's physical ability (i.e. strength or reach).

Workshop II: The Barriers to Achieving the Vision and How to Address Them

Great Expectations

Doc-In-A-Box

MyDrug.Com

Nursing Home No More

When Home Is Not Enough

Death By Appointment

The first workshop developed a vision of the health care system of the future. The second workshop discussed the societal, health establishment, and economic and regulatory aspects of the current health care system. The participants were asked to identify the changes needed to make the vision possible, the barriers to attaining the vision, and solutions to address those barriers.

To stimulate discussion, ACG staff developed presented the second workshop with a summary of the vision from the first workshop, a set of scenarios (see Appendix C) that illustrate how the vision could affect individual lives, and a "straw man" set of changes to attain the vision.

Workshop participants began with a spirited discussion about the vision. In particular, some voiced strong concerns about, as one participant put it, "the sterile high-technology perspective" that it seemed to take. Several participants articulated the need to maintain, even as we look for technological solutions, the human connection and the critical role of the trained medical provider in health care—to respect the art, even as we improve the science, of healthcare. Perhaps as a result of the way the opening material was presented, it was not clear to the second workshop participants that the human element had been an integral part of the discussions of the first workshop—as, in fact, it had. Another issue raised by the participants was that the vision seemed to be a "yuppie technocratic vision" tailored to the economically well off. To be persuasive, the vision must ultimately seem accessible and attractive not just to an economic elite, but to nearly all our citizens.

Changes Necessary to Attain the Vision

The participants divided into three groups, each with a mixture of professional backgrounds, to identify changes needed to attain the vision. The groups found changes necessary in the categories of society, lifestyle, medical interventions, and modes of medical delivery.

Two themes cut across these discussions on needed changes: the need for increased education and the need for the development of an integrated community perspective relative to health care.

Education will be necessary for people to understand their roles, responsibilities, and rights in the new health care paradigm. The will need education to take a proactive role in their own health care. Education will be critical to evolving expectations that we each have about ourselves, and that society has about each of us, as we age.

For the new paradigm represented by this vision to evolve, it is also necessary that there be greater integration of individuals into a community—and a more integrated management of each person's health.

The following table shows the specific changes that were identified by the group as requiring attention if the vision is to be realized. The breadth of these changes suggests the extent to which this new vision implies a fundamental shift in how we view the aged and how we deliver health care.

Changes Required to Attain the Vision	
Changes in Society	Changing the expectations of what it means to be "elderly (for self and others) • Association with disability (i.e. loss of physical/mental function) rather than age. • Change “attitude of (life) death, frailty, and disability” – new life story “it’s a wonderful life” • Restore the concept of "elders". • Change the expectation that growing old will eventually lead to being dependent - or - to isolation
	Changing the nature of work from "work to retirement " to "Life Long Contribution" (participation)" does not have to be a job (options/volunteer) – life long learning • Need corporate responsibility • Will change the economics
	Increasing the sense of community for elderly - through neighborhood organizing, community assessment, but also using technology such as TV and the Internet to augment genuine social interaction
	We will need to have more disability neutral environments - like transportation
	Our general population will need more understanding of human physiology
	Our population will have to become more comfortable with technology - and technology will have to become more friendly
Changes in Lifestyles	Shifting loci of health decision making - including to the community
	Homes will need to be made more safe
	More continuous health monitoring
	Delivering advice/reassurance using more tech-assisted family and community caregivers, less doctors
	Individuals will need to take more accountabily for their health care, i.e. adherence/compliance
	Improve the education level of our population as a whole - better human physiology understanding, better chance of healthy lifestyle
	Change expectations related to continued learning - at all levels of population and all phases of life. This improves coping skills, improves mental outlook, improves health outlook on life.
Changes in Interventions	Individualized and Remotely Delivered Drugs/Therapies - e.g. genomics
	Pervasive, Distributed Assistive Devices and Rehabilitation - including more nanotechnogies, micro machines
	More holistic approach - includindg non-medical interventions as prevention
	Enhanced public health interventions (eg, water infrastructure and healthy fast food)
	Improved security of information
Changes in Medical Delivery	Adaptive appropriate health monitoring and early warning systems-(computer watching for changes to alert)
	Greatly increased ability to convert this large amount of "data" into useful information and knowledge
	Changing the nature of the hospitals to more specialized, fewer general
	Invasive/intensive interventions will need to be shorter, fewer, and more mobile
	Develop layered approach applying the appropriate resource to need - includes changing roles
	Science not art – predictive science (measured)
	Optimized use of institutional care
	Less futile care because better able to predict success of interventions

Barriers and Solutions to Achieving the Vision

After articulating a view of the changes necessary to attain the vision, participants were divided by professional background into three groups, one each focused on the societal, health establishment, and economic and regulatory dimensions of health care. Each group was charged with identifying barriers, and solutions to the barriers, to bringing about the changes prerequisite to the vision. (The detailed final notes on barriers and solutions developed by each group appear in Appendix D.) Several themes emerged from the sub-group discussions.

Themes related to the six elements of the vision

Changing the expectations of what it means to be "elderly"

Significant barriers to this element were perceptions and attitudes. For example, such attitudes are those that equate chronological age with being disabled; those that allocate health benefits on the basis of age rather than need; and those disrespect and devalue the elderly. Proposed solutions to these barriers centered on education and training to address the perceptions and attitudes.

Adopting the Paradigm of "Life Long Contribution" rather than "Work in Order to Retire"

The barriers to this element also included the assumption that the elderly are not valued by society. In addition, regulatory and legal barriers to evolving careers or volunteering were identified. For example: teaching certification requirements or union restrictions may hinder the ability to "tele-volunteer" in different geographic jurisdictions. In addition, the potential for legal liability and the high cost of medical malpractice insurance can deter retired medical personnel from volunteering their expertise.

As with the first element, participants called out education and training as important to promoting this new paradigm. They also suggested various mechanisms and incentives, such as: national professional licensing, extension of legal "good samaritan" protection to volunteers, identifying new venues for contributions by the elderly, and providing incentives for productivity over leisure. Another theme emerging here as well as throughout the workshop, as that of "saging," which refers to the need to restore respect for the wisdom of the elderly and utilization of the knowledge they have to offer.

Delivering health care to the individual rather than delivering the individual to health care

The barriers this to element are largely financial and regulatory. For example, the current system is built on episodic care for illness, rather than wellness care. Another significant barrier is that current technology is not small enough, affordable enough, or capable of capturing sufficient information to make this element feasible. Suggested solutions

encompassed several examples of enabling technology, such use of robots for companionship or care and improved for information gathering and analysis.

All three groups noted that the current health care situation is perpetuated by the existing financing mechanisms. The very important inverse statement is that changes to the existing system are not supported under existing financing mechanisms. The economic and regulatory group suggested that an important driver in changing this perspective of health care financing might be large employers, who represent a large source of funds flowing into the system.

Shrinking institutional care (or at least optimizing and enhancing it) and Replacing general hospitals with specialized facilities

Many of the identified barriers coalesced around issues related to the fact that the health care system will have to respond to many people in different situations and with different needs. A common sense across the groups was that the focus should be enhancing and optimizing institutions rather than shrinking them—even though doing so may ultimately shrink them. Solutions in these two areas had perhaps the largest technology-enabling components of all the areas, ranging from secure data collection and protected data availability, to tele- or virtual medicine, to mobile clinics.

Shifting the locus of medical decision-making back to the individual (and community)

All three groups touched upon the diversity of the population— in values, education, geographic location, economics, and cognitive abilities—and the resulting need for a system that encompasses this diversity. Participants noted that this group was not representative of society as a whole, and that any realistic plan must be responsive to a much broader range of people. Several opined that the vision as it stands seems most applicable to a middle class, well-educated and privileged group, and that it is important to develop a clearer picture of who the "elderly" will be in 20 to 25 years.

Not surprisingly, the proposed solution to this barrier had a strong education component. With the goal of giving the individual more control and responsibility over medical-care decision-making, the need for a better informed and technology-literate population becomes of greater importance. Technology aimed at empowering individuals and communities to make their own health decisions should be more human-friendly technology, should appropriately balance privacy and service, should enhance information transfer, and that should enable communities to form.

Cross-cutting Themes

Several cross-cutting themes pervaded the second workshop. Although many of these appear above, they deserve special emphasis.

Complex and Interrelated System

Discussions revealed the degree to which health care is a complex of multiple, interlocking problems. For example, the group deliberating on societal barriers and solutions noted the extensive linkage between social and economic barriers. Economic and social diversity in the population contributes to the complexity of the system. Although technology will play an increasingly important role, social support of that technology is necessary to make it work. Also relevant to the systems theme was that health care must evolve to encompass the social, cultural and spiritual, as well as the traditional medical, needs of the individual.

Education

A recurrent theme was the preeminent need for education at all levels, and for all ages, to make this paradigm shift real. Education would be necessary for everyone involved—from the medical establishment, to those responsible for regulation, to employers, to the very young, to the elderly widow in her home. People will need to be educated that:

- "elderly" does not have to mean disabled or separated from society;
- each person has an obligation, to the extent possible, to manage his or her own health throughout life; and, accordingly,
- each must learn more about health maintenance, medical options, and enabling technologies.

Caregiver's Role

Although the entire second workshop was evenly split between men and women, the sub-group discussing social barriers was composed only of women. It turned out that this group comprised mainly caregivers, who, in our society, are primarily women. Caregivers and helping professions are not highly rewarded: this group of careers tends to be less well paid and less respected than the other groups represented in the workshop. This in turn prompted discussion that the vision of the first workshop would in fact imply increased roles for caregivers. Therefore some thought would need to be given to enabling caregivers and enhancing their value in the system.

Communicating the Vision

The scenarios were a useful mechanism for describing how the vision would be lived. More than one person advocated adding more scenarios to those that were presented. There was some concern that the scenarios all focused on home-based care, because the home can be isolating as well as nurturing. Scenarios appeared to focus on managing decreased mobility by enabling people to stay at home and be connected via technology, rather than using technology to increase mobility. A new scenario should show how people might be gotten out of their houses. Another suggestion was that a scenario should describe intergenerational living in a group setting as well as people living alone and communicating through technology.

Conclusion

The goal motivating the vision for technology in the future health care arena is to minimize the effects of aging and acquired disability. Keeping the elderly healthy longer should reduce health care maintenance costs minimize the cost of care for patients who cannot be kept in the "stable" category.

The participants of the first workshop developed a vision of a human-centered the health care system of the future in which there is an important role for technology. The participants of the second workshop stressed the importance of the human dimension in the vision and the extent to which achieving the vision will require a fundamental shift in how society views the elderly as well as in how health care is provided to the elderly.

Health care for the growing population of elderly will require addressing a complex system of interrelated economic, social, and regulatory factors. And, although technology can play a fundamentally important role in achieving the vision, such technology must be developed within a societal context. Moreover, people will have to be educated not just about how to use new technology, but how to better manage their own health.

A: The Advanced Concepts Group

B: List of Workshop Participants

C: Scenarios to Describe the Vision from Workshop I

D: Barriers and Solutions Identified in Workshop II

A: The Advanced Concepts Group

The Advanced Concepts Group (ACG) at Sandia National Laboratories was charged by Sandia Director Paul Robinson to investigate potential contributions that Sandia might make to solving long-range future problems of the nation. Led by Sandia's Principal Scientist, Gerry Yonas, the current group consists of approximately 11 full-time and 5 part-time staff with very diverse technical backgrounds—physics, chemistry, math, engineering, political science, communications, and cultural anthropology. The staff diversity is recognition of the multi-dimensionality of the problem—identifying socially valuable contributions for science and technology in a world that is changing rapidly along both human and technical dimensions. ACG staff rotate on a two- to three-year assignment both so that they can both approach this task with clarity and freshness and so that they can take what they learn back into the organization at large.

B: List of Workshop Participants

Participants at Workshop I

Dr. Dale Alverson, University of New Mexico Telemedicine Program
Margaret Griffin, The Heart Hospital of New Mexico, RN, VP of Clinical Services
Michelle Grisham, New Mexico State Agency on Aging, Director
Jerry Harrison, Ph.D., New Mexico Health Resources
Dr. Steve Hightower, Geriatric Physician
Nina Kelley, Ph.D., Louisiana State University Health Center
Dr. Richard Re, Ocshner Clinic and Hospital
Dr. Paul Roth, University of New Mexico Medical School
Dr. Richard Satava, Yale University School of Medicine, Surgery
Binh Q. Tran, Ph.D., The Catholic University of America, Biomedical Engineering

Participants at Workshop II

Brian Crawford, Astra Zeneca Pharmaceuticals
Blane Eisenberg, CISCO Systems, Inc.
Meghan Gerety, Audie L. Murphy Memorial Veterans Hospital
Joie Glenn, New Mexico Association for Home Care
James Goodwin, Sealy Center on Aging, University of Texas Medical Branch
Michelle Grisham, New Mexico State Agency on Aging
Paul Hewitt, Center for Strategic and International Studies
Martin Hickey, Lovelace Health Systems
Mike Nunez, William M. Mercer, Inc.
Joyce Pullen, Senator Pete Domenici's Office
Patrick Quinlan, White House Office of Science and Technology Policy
Muriel Ross, University of New Mexico/NASA Ames
Peggy Shepard, Representative Heather Wilson's Office
Liz Stefanics, Open Hands
Deborah Walker, Matthews Media Group

C: Scenarios to Describe the Vision from Workshop I

Great Expectations

Sunship Airlines has a large staff of aircraft maintenance personnel scattered all over the world. They have an aggressive multi-phased career program which looks like:

- New workers serve as apprentices under experienced, older workers. Some of the training is hands on and some is "virtual." They have found that a large part of their success is tapping into the "empirical" knowledge of their older staff.
- As experienced staff age, they look forward to a distinguished, but physically less demanding, role in the apprentice program to help train new staff.
- Experienced, older staff are often called upon to help in the development of new processes and tools - working closely with the younger workers on bright new ideas.
- Most employees never “retire”, but they are encouraged to work from home in many of the mentoring and consulting roles.

Doc-In-A-Box

June is a 75-year-old widow who lives alone in a "smart" home. Her appliances, including her medication dispenser and many health sensors, some that she wears as part of her jewelry, some that are implanted and some that are located in her bathroom, are all networked. These send data to "Doc-In-a-Box", her network-based ‘virtual doc’, which presents information to her through her TV set. Each morning, “Doc B”, as she likes to call her and who looks an awful lot like Juliana Margulies, comes on the screen and reassures her that everything is OK. “Doc B” also retains the data in a server and analyzes variances in her vital signs and blood chemistry on day–to-day, week-to-week, and month-to-month intervals.

Each morning, June turns on her TV (using her remote control which simultaneously measures her vital signs and does a complete non-invasive blood chemistry) to check the local weather, local news, the status of her investments, her family news and her personal health report from “Doc B”. It reports to her the status of her major health concerns, arthritis and high blood pressure, reminds her of her status on the diet she is attempting to follow, reminds her of her status of her medications for the day, and alerts her to any unusual health events.

Today, “Doc B” tells her that her blood pressure has been elevated for a long enough time that an appointment has been made with her human doctor. An email message has been sent to her children (at her request) informing them of her change in status and the upcoming appointment. “Doc B’ has also sent all of her health info since her last office visit to her blood pressure specialist.

MyDrug.Com

Janice, 71, an ex-accountant living in Denver, noticed the first signs of Alzheimer’s disease a few years ago and confirmed that she had a propensity for the affliction with the disposable “Genome-at-Home” test kit. In her ‘retirement’, she has been teaching algebra via her home cable TV transmitter/receiver to 9th graders on the Navajo Reservation in Crownpoint, NM. They couldn’t find a teacher who wanted to live out there, and so advertised for one on the web.

Lately, her students have mentioned to her that she seems to be forgetting what she has assigned for homework. She got really nervous when she couldn’t remember one of her student’s names. Janice logged onto her neural specialist physician’s web site with her concerns. With 196 genes affecting Alzheimer’s, she needed more specific testing than could be accomplished with her “Doc-in-a-Box” home health system.

Her human doc had her come in for an analysis on what Janice affectionately calls the ‘NAG’ (for Nanotech Appliance for Good health) which identified an imbalance of 23 proteins. That info was sent over a secure web line to Janice’s ‘Doc-in-a-Box’, which analyzed the results against her present medication and sent a request to MyDrug.Com, a personalized drug creation and fabrication company. Two days later, a new ‘prescription cocktail’ of protein enhancer drugs, never before assembled for human consumption, was delivered to Janice. Within two days, she was back to normal, preparing her students for an exam on the quadratic equation.

Nursing Home No More

Anna is 95 years old and lives alone in Phoenix in a very "connected" home. Like June she uses her "Doc -In-A-Box" for health advice and she is visited regularly by local friends. However, Anna has a special role. She supervises the activities of her great - great grandson, Dave, age 8, as he comes home from school in Portland, each afternoon until his parents return from work. When Dave pushes the front door bell in Portland, it rings on Anna’s TV computer in Phoenix and a “picture-in-picture” image of the front door appears on her screen. Anna remotely controls the locks on the doors, and lets Dave in. She also controls the appliances in the house and

starts the microwave heating the mini-pizzas that Dave really likes. She can control "ROBIE", a small robotic dog that plays with Dave but also acts as Anna's "eyes" as Dave roams through the house. Anna helps Dave with his homework and watches over him as he practices batting in the back yard. Sometimes they enjoy a "virtual snacktime" together when Anna gets to tell Dave some of the stories from her past and Dave tells Anna about his friends at school.

Anna has major back problems, so she no longer drives and has many small robotic devices in her home that help to accomplish the housework. She does not go out often, but when she does, she uses the shuttle system for her neighborhood. This runs in a loop through the neighborhood, stops just outside her door every 15 minutes, and offers her access to the hair dresser and the grocery store. It also has a transfer to the larger transit systems for access to the hospital and the airport.

When Home Is Not Enough

George is 75 years old and lives in a well connected home, too. His "Doc-in-a-Box" has been monitoring his circulation problems very closely but today sensors picked up an indication of a blood clot, putting George in real danger of a stroke. The emergency mode took control and contacted "911". Because of the real time surveillance data passed to the emergency personnel, they have arrived to transport him to "The Stroke Hospital" nearby which specializes in emergency treatment and critical care for stroke victims. The emergency personnel used a small non-invasive hypersonic declotting device to try to break up the clot on the way to the hospital but it appears that has not worked. George is being prepared now, only 20 minutes since the sensors detected the problem for a rapid chemo-surgical procedure to dissolve the clot. They expect him to be home with no permanent damage in a few days.

Death By Appointment

Arnie is 93 years old and has been struggling with a bad heart valve for years now. He has been lucky to be one of the first users of the "Virtual Body" which is an individualized model of his body. It has allowed very accurate predictions about the results of various proposed interventions. However, interventions are becoming less and less effective as more of the body seems to be weakening. Yesterday, Arnie's 'Doc-in-a-Box' informed him that the prospects are very poor and his physician is running the last simulations on his Virtual Body to see if any of the latest interventions might be successful. Today, his physician has told Arnie and his family that none of the simulated interventions were successful. The predictions are that Arnie will live from 1 week to 3 months. Arnie and his children begin preparing for the end.

D: Notes from Barriers and Solutions Sections of Workshop II

Vision	Health Establishment Barriers & Solutions
1. Changing the expectations of what it means to be "elderly; 2. Adopting "Life Long Contribution" rather than "Work in Order to Retire" paradigm	
3. Delivering health care to the individual rather than delivering the individual to health care	• Technology assumes relationship/coaching • Health care system built on tradition of episodic care for illness, not continuous care for wellness • Financing mechanism limit innovation in care delivery, by constraining process. • Economics rewards equipment, episodes • Reimbursement mechanism artificially divides sectors of care, eg, LTC, acute care • What gets paid gets done- dollars drive practice • Why geriatrics and gerontology is unattractive • Technology not yet small enough/affordable enough • Today's technology can't capture all information necessary in medical encounter- psychological factors building relationships collateral information • Regulatory barriers to practice across state lines- medicine is regulated by states not federal gov. • May not work with cognitively impaired persons
4. Shrinking institutional care (or at least optimize and enhance); 5. Replacing general hospitals with specialized facilities	• Tension between perceived safety and standards of care and patient autonomy. Institutions appear to prefer safety to autonomy • Shift in control when person enters hospital – non participatory care • Architecture & cost of reconfiguring hospital • Connotations "general" vs. "specialized" consider substituting patient-centered customized environments. • Inverse relationship between institutional size and personalized care
6. Shifting the focus of medical decision-making back to the individual (and community)	• Medical records have evolved from tools for providers to public records – may have less information about medical decision making • Disclosure of diagnostic decision making may undermine provider/patient relationship • May not work with cognitively impaired persons • Decision making process is not explicit – often implicit

Vision	Societal Barriers & Solutions
1. Changing the expectations of what it means to be "elderly"	Barriers: • Attitudes need to change, needs need to be addressed regardless of age: state of mind, assumptions about chronological age. • Needto establish parameters to get benefits based on need rather than age. • Change sense of what it is to be "elderly" respect for experience and expertise, not a burden. • Medical system "ghetto-izes" people through specialization (geriatrics). • Perceptions of population about aging are negative. Solution: • Blitz marketing of elderly doing things, message over and over to integrate message into society, showing the elderly using the technology, integrating disabilities into the message, has educational import. • Existing systems (public schools, families, churches) need to be involved in educating about the values.
2. Adopting "Life Long Contribution" rather than "Work in Order to Retire" paradigm	Barriers: • Assume social security and Medicare will be sufficient. • Perception of when we are "old" or aged or of value. • Money is seen as primary value in life, have lost our bartering system. • Malpractice insurance is a barrier to volunteerism for doctors. Solutions: • Recognize the need to prepare financially for our care in the future. • Need to develop the concept of "saging". • Need to expand society's understanding of valuable contribution to society that is not related to making money. • Reinforce value of caregiving, volunteer work. • Govt/Legal extension of "good samaritan" protection to medical volunteers.
3. Delivering health care to the individual rather than delivering the individual to health care	Barriers: • Transportation is a big impediment (get out of the house to the curb, out to shopping, appointments, social). Loss of spontaneity, control, and independence. Medicare does not pay for electric wheelchairs. • Medical professional's fear of technology, that it will take away their job, status, turf. • Turf, territory issues are a barrier for 3,4,5. • No reimbursement for tele-medicine. • Mental health is an important component, but has traditionally been the "step-child" and not taken as seriously. • Labor issues (shortage) within the healthcare industry, also has an aspect related to gender-related professions. Solutions: • Immigrants providing care. • Robotic companionship/care.

4. Shrinking institutional care (or at least optimize and enhance)	Barriers: • Prison population (and other institutionalized groups) not well served. • Haven't really looked at options to nursing homes. Solutions: • Telemedicine, virtual medicine can provide better/more care, reduce need to taking people to a facility, reduce costs. • Mobile clinics. • Take a new look at ways to meet the needs of individuals.
5. Replacing general hospitals with specialized facilities	Barriers: • Crisis in this country in expertise on aging and in general, insufficient functional specialty to address issues. • Reimbursements to experts in geriatric care are less than to experts in other areas. Solutions: • Data –mining capabilities allowing any med professional to tap into, decision support systems through database support. • Encourage retirees in geriatric care to participate in caregiving on a volunteer basis.
6. Shifting the locus of medical decision-making back to the individual (and community)	Barriers: • The human-computer interface is not useful for everyone, and information transfer tends to be cognitive based and not focused on needs of population (moving objects, colors). • Lack of community relationships to provide monitoring and the support structures needed for some individuals in their decision making. • Aging in very different environments, such as situations of poverty or rural life, with or without family. • Bridging different cultures in the same community. Health care and decision-making differs across cultures (this is accentuated with age). • Former life experience can require individualized care: revert to native language in older patients, reverting to previous stage (combat violence) in Alzheimers patients. • We think we are educating people, and we are not. One aspect of this is the drop-out problem. • Cost of moving to virtual community is very high and labor intensive. Solutions: • Need a visual, not just cognitive, element to get information across. Need to think of an audience that has auditory and visual issues. There is research on how to increase information transfer. • Technology needs to take into account the things that can cause illness. • Community organizing around neighborhood needs as a health issue. • Technology "Aware House" or mobile devices, but need to balance privacy and patronage.

Vision	Economic and Regulatory Barriers & Solutions
1. changing the expectations of what it means to be "elderly	Barriers: • Old employees are expensive • Salary seniority • Liability • Loss of status • Questionable reliability for some jobs • Electricity etc. – we've lost value of elderly in community • Soc Sec. - Medicare …Dis-incentives for working (elderly) Overcoming Barriers: • Value Added • Elderly workers more competent for some jobs • Change definition of value. They have wisdom , etc. Recover – value of elderly – Tech Asst. • Sufficient venues for elderly to contribute in retirement
2. adopting "Life Long Contribution" rather than "Work in Order to Retire" paradigm	Barriers: • Teacher/employee certification • Unions • Locality • Questionable reliability for some jobs • Elderly may not want to work • Soc Sec Benefit Age too low • Soc. Sec. - Medicare Dis-incentives for working (elderly) Overcoming Barriers: • National licensing/reciprocity • Tech. Assistance to making work more gratifying • Incentive for productivity over leisure • Venues for elderly to contribute even in retirement • Re-Skilling
3. delivering health care to the individual rather than delivering the individual to health care	Barriers: • Medicare/medicaid focused on traditional doc/patient Relationship • No $ for case mgmt, home telemedicine • Who pays - private or public uninsured?? • Risk of the new (maintain status quo) • Not enough education • Expectation of max.. entitlement (Leads to political pressure) • Technology inequalities • Liability on Designer Therapies • Cost (financial incentive to have doc in the box) • Medical Societies - professional opposition • Technology phobia Overcoming Barriers: • Education • Home Infracture Server

	• Value-Added • Legislation ($) • Large Employer Incentives as driver
4. shrinking institutional care (or at least optimize and enhance)	Barriers: • Still large # of dependent people Solutions: • Concept of institutions will not go away • Transformed not eliminated • Tech enabling - makes institutions better
5. replacing general hospitals with specialized facilities	Barriers: • Spec. facilities have special interests - off load hard cases • Elderly patients often need generalized care or multiple specialized care Solution: • More integrated specialists • Every room is an ICU • Dist. Nodes of care – shopping mall diagnosis centers, simple surgery, etc.. • Info back—plane – Private and secure
6. shifting the locus of medical decision-making back to the individual (and community)	Barriers: • No price sensitivity • Not enough education • Indiv. Resistance to indiv. Decision-making • Not everyone wants info. • Segment of population has different sources of comfort in decision making. Comes familiarity of what they know about the topic. Solution: • Education • User friendly